REINHOLD ENVIRONMENTAL Ltd.

2011 APC Round Table
& Expo Presentation

July 11-12, 2011, in Cleveland, OH / Hosted by FirstEnergy

Cliffside 6 Integrated AQCS

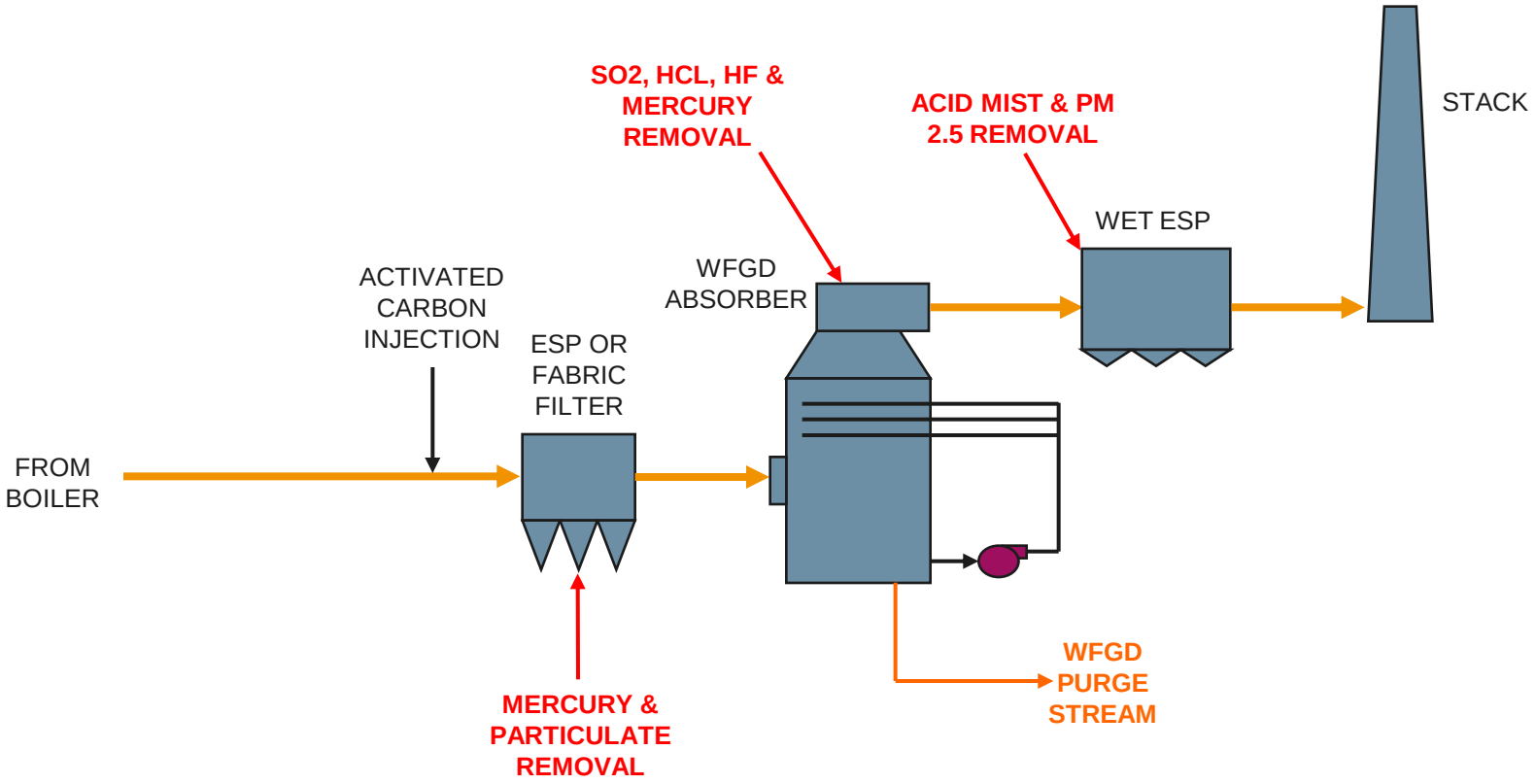
2011 APC Round Table

Phil Rader

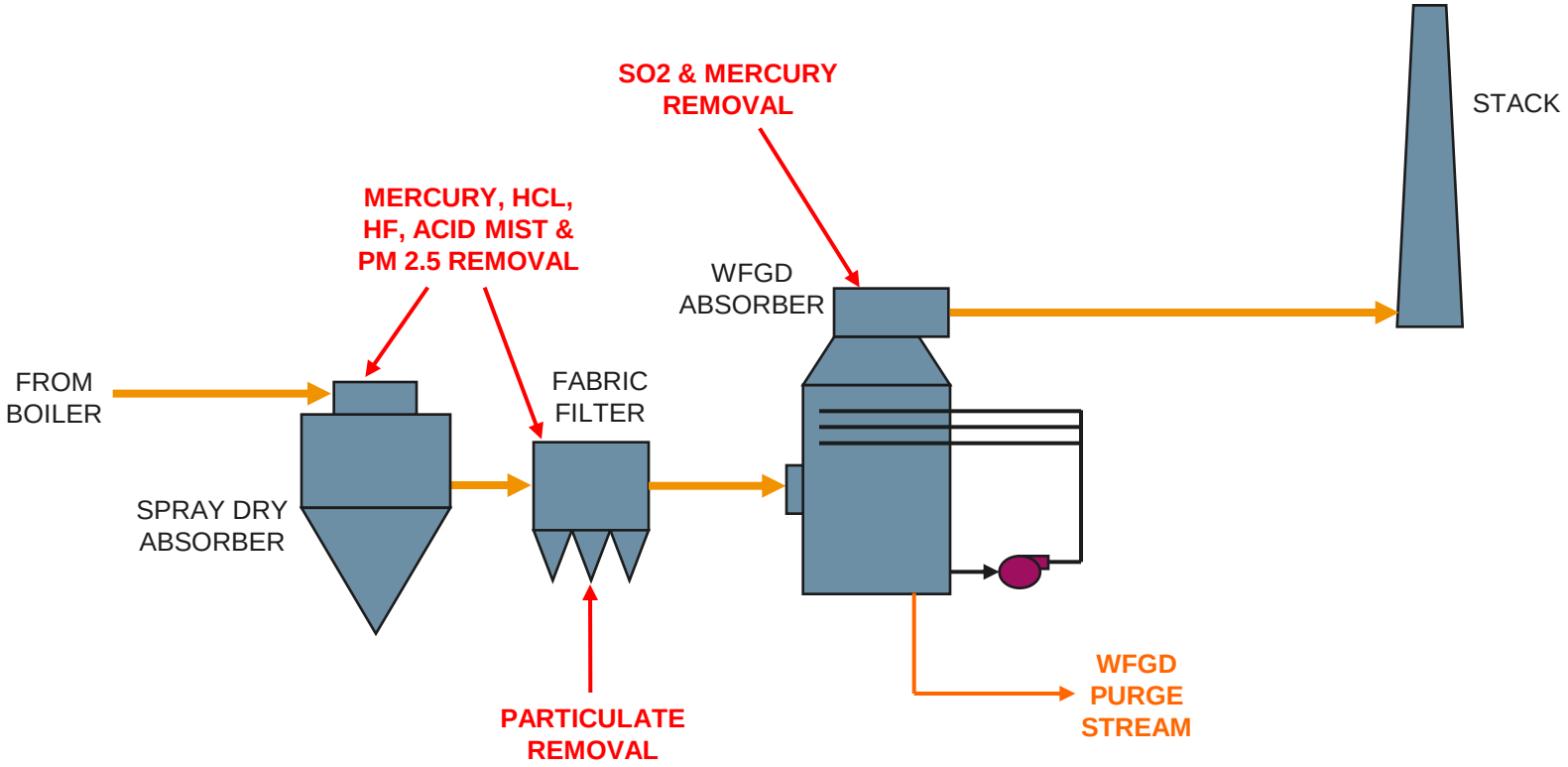
Cleveland, OH – July 11, 2011

POWER | ALSTOM

Conventional High Sulfur AQCS



Integrated AQCS

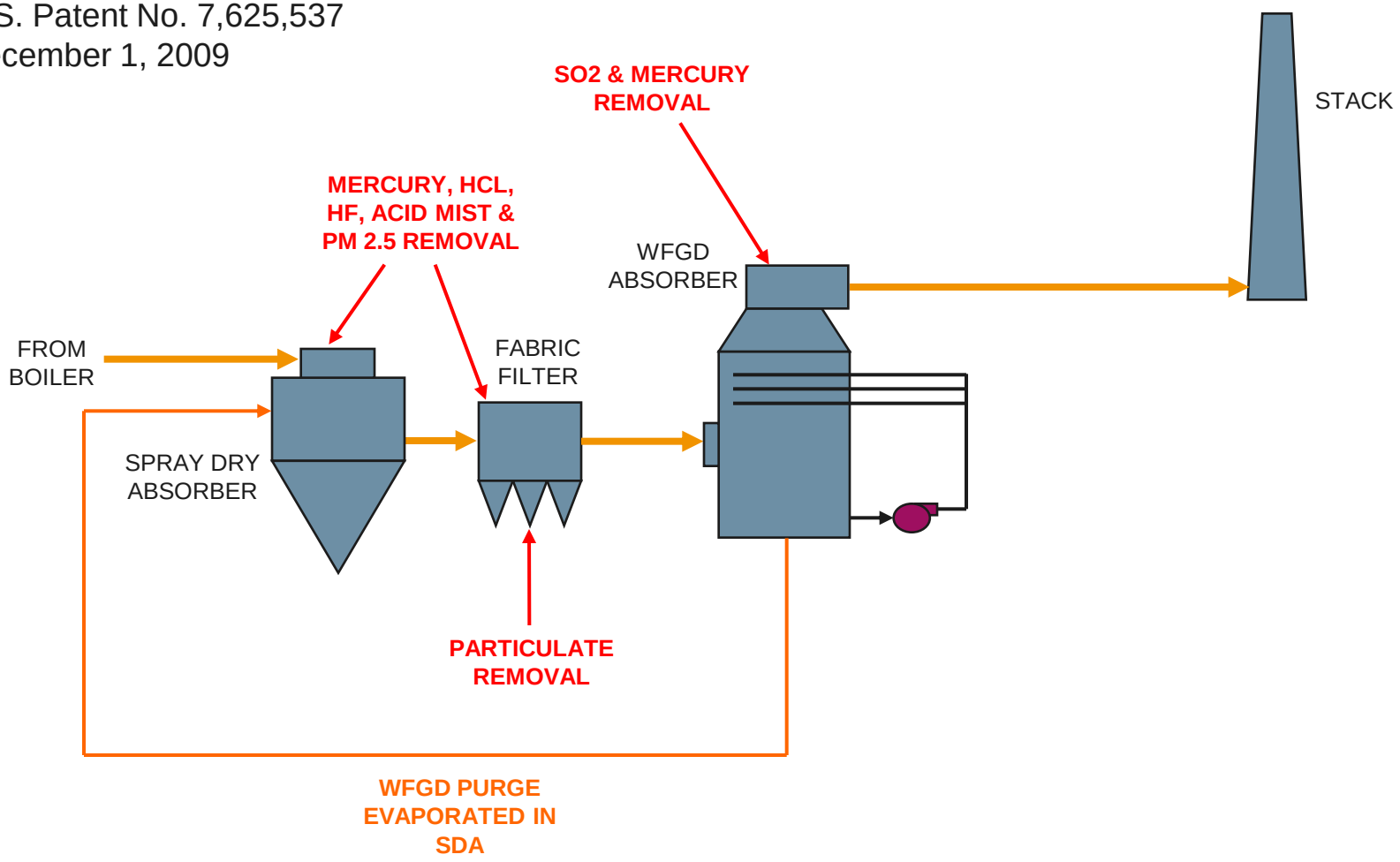


Integrated AQCS

INTEGRATED DRY AND WET FLUE GAS CLEANING PROCESS AND SYSTEM

U.S. Patent No. 7,625,537

December 1, 2009



Cliffside Pilot Plant

- SDA/FF pilot plant (~1 MW) constructed at Cliffside Unit 5
- Testing carried out in Aug/Sept 2007
- Testing confirmed:
  - SO_3 emissions < 1 ppm
  - HCl vs. SO_2 removal
  - Stoichiometric ratio
  - Byproduct composition

SO_3 Control with DFGD

- Achieve total particulate emission and opacity limits without WESP
- Uses low cost lime reagent
- Compared to 800 MW plant with WESP:
  - Capital cost savings (~$40-50 M)
  - O&M cost savings ($1.0-1.5 M per year)
- Carbon steel SDA vs. alloy WESP
  - Lower material/erection cost
  - Less exposure to alloy price volatility
- WESP construction
  - Labor intensive
  - Significant alloy field welding

No FGD Waste Water

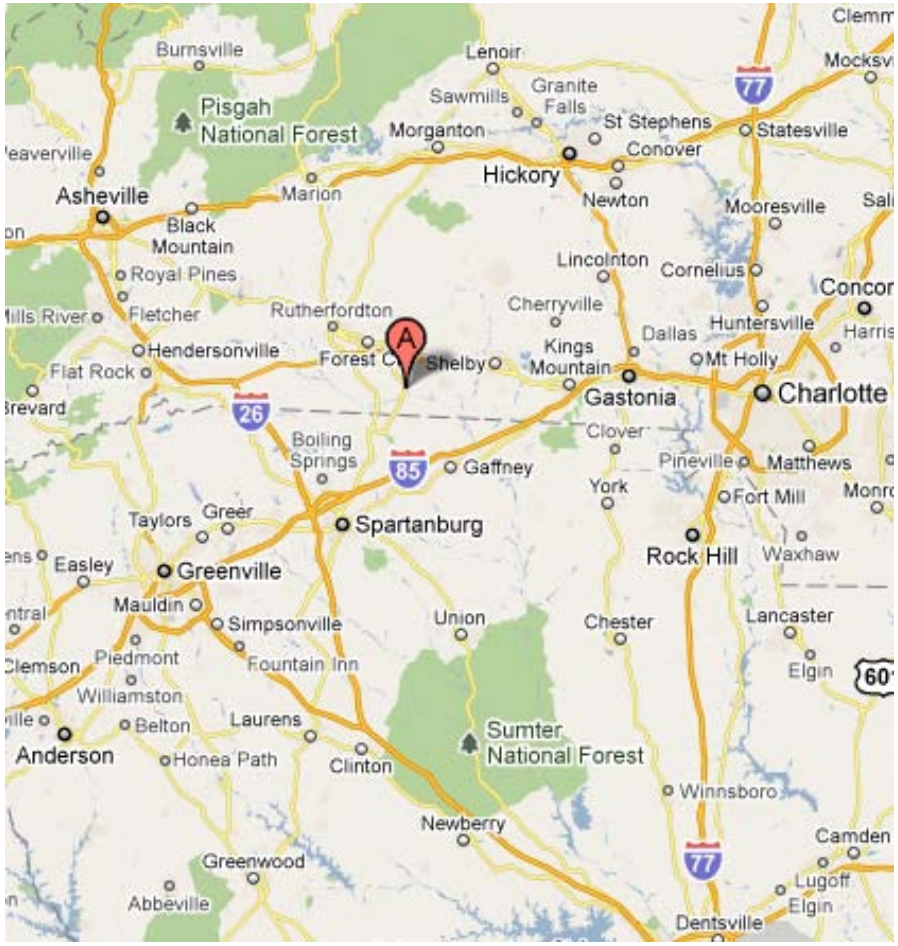
- Eliminate wastewater treatment / disposal for AQCS
- Compared to 800 MW plant with WWTS:
  - Capital cost savings (~$30-35 M)
  - O&M cost savings ($1.0-1.5 M per year)
- Reduce land requirements
- Unit 5 waste water can also be accommodated by Unit 6 SDA under most circumstances

Added Benefits

- Determined to be a minor source of HAPS
- Reduced WFGD material cost due to pre-collection of chlorides by DFGD
- Lower make-up water consumption
- Lower potential for Hg re-emission from WFGD
- Lower Hg levels in gypsum

Cliffside Steam Station

- Capacity: 760 MW
- Location: Cleveland and Rutherford Counties, NC
- Units 1-4 on-line in 1940s
- Unit 5 (560 MW) on-line in 1972
  - ESP initially
  - SCR in 2002
  - WFGD in 2010
- Unit 6 (825 MW) on-line in 2012
  - SCR
  - Integrated AQCS (SDA/FF/WFGD)



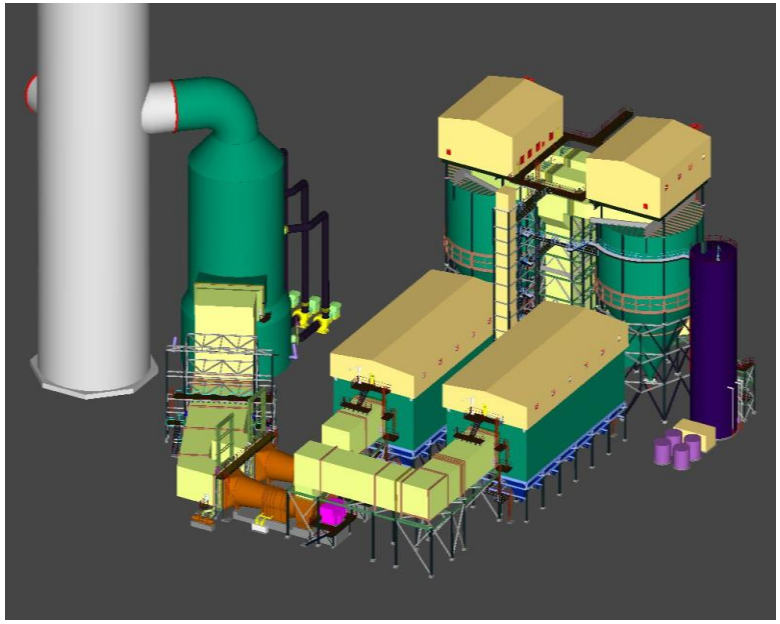
Cliffside Plant Overview

Cliffside 6 Environmental Highlights

- Permit issued by DENR on January 29, 2008
- Compared to the existing plant, the modernized plant will emit 80% less SO_2, 50% less NO_x, and 50% less Hg while generating more than twice the electricity
- Permitted as a “minor source” of HAPS
- Awarded US Department of Energy clean coal tax credit of $125 million
- First US coal plant to include CO2 mitigation plan – requires Duke to retire an additional 800 MW by 2018

Duke Energy Cliffside 6 Integrated AQCS

Project Scope	Spray dryer, fabric filter, spray tower, lime/limestone preparation and feed systems, by-product dewatering system, ductwork, fans, erection and commissioning advisors
Location	Cliffside, NC
Capacity	825 MW
Start-Up	May 2012
Fuel	Eastern Bituminous
Spray Dryers	Two 68 ft dia SDAs; three 200 hp atomizers per SDA
Fabric Filter	Two 12-compartment casings; 8-meter PPS/P84 blend bags
Spray Tower	One 61 ft dia tower; 5 spray levels
Reagent	Lime, limestone
By-product	Commercial gypsum



Duke Energy
Cliffside Unit 6
Cliffside, NC

Cliffside 6 Construction

Cliffside 6 Construction

Cliffside 6 Construction

Cliffside 6 Construction

Cliffside 6 Construction

Cliffside 6 Construction

Lifecycle Cost Analysis

Technology		Integrated FGD	FF/WFGD/WESP
Total Plant Capital Cost	$	240,000,000	310,000,000
Normalized Capital Cost	$/kW	300	388
Plant Capacity (per unit)	MWe	800	800
No. Units		1	1
Plant Capacity Factor	%	85	85
Equivalent Annual Operating Hours	hr	7,446	7,446
Escalation Rate	%	4.0	4.0
NPV Discount Rate	%	10.0	10.0
SO2 Production Rate	lb/hr	26,386	26,386
ID Fan Flue Gas Flow	acfm	2,562,000	2,692,035

Lifecycle Cost Analysis

Technology		Integrated FGD	FF/WFGD/WESP
Total FGD Power	kW-hr/hr	14,225	15,587
Power Cost	$/kW-hr	0.030	0.030
Pressure Drop	in. w.g.	36.5	34.5
Booster Fan Power Consump	kW-hr/hr	13,714	13,620
Total Power	kW-hr/hr	27,939	29,207
Limestone Consumption	ton/hr	32.0	32.6
Limestone Cost	$/ton	20.00	20.00
Lime Consumption	ton/hr	1.3	0.0
Lime Cost	$/ton	110.00	110.00
Alkali Used		NA	MgO
Alkali Consumption	ton/hr	0.0	0.2
Alkali Cost	$/ton	0.00	400.00
Gypsum Production	ton/hr	74.0	75.5
Repair/Maintenance	% of TPC	1.5	1.5

Lifecycle Cost Analysis

Technology	Units	Integrated FGD	FF/WFGD/WESP
Auxiliary Power	$/yr	6,241,001	6,524,350
Limestone	$/yr	4,765,440	4,860,749
Lime	$/yr	1,064,778	0
Alkali Injection	$/yr	0	648,789
WWTS Reagents	$/yr	0	1,300,000
Gypsum	$/yr	(2,755,020)	(2,810,120)
Repair/Maintenance	$/yr	3,600,000	4,650,000
Total	$/yr	12,916,199	15,173,767
	$/MW-hr	2.17	2.55
Total Plant Capital Cost	**$**	**240,000,000**	**310,000,000**
NPV (20 years) - Total Annual C	**$**	**145,160,000**	**170,530,000**
Total Lifecycle Cost	**$**	**385,160,000**	**480,530,000**

www.alstom.com

POWER | ALSTOM